OPERATIONS MANUAL FOR THE GOES SATELLITE DERIVED SEA-SURFACE TEMPERATURE (SST) PROCESSING SYSTEM

November 1, 2000

Prepared for:
Eileen Maturi
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Camp Springs, MD 20247

Prepared by:
Steve Olson
Research and Data Systems Corporation
7833 Walker Drive
Greenbelt, MD 20770

Table of Contents

1.Operations Manual Overview

The GOES Satellite derived Sea-Surface Temperature Processing System Operations Manual provides computer operations personnel with a description of the software and operational environment associated with the Processing System and is intended to aid the operator in seeing that the System software is routinely and reliably executed. As such, it provides computer operations personnel with instructions for monitoring the various components of the SST Processing System as well as instructions for the recovering processing when possible. Chapters 2 and 3 provide a high level discussion of the Processing System and discusses the individual processes which make up this system. Chapter 4 outlines specific procedures to be taken by computer operations personnel regarding monitoring and recovery of processing. Chapter 5 describes system information which includes program scheduling and data files. Chapter 6 describes procedures to be taken for restarting McIDAS-X and rebooting the UNIX workstation. Lastly, Chapter 7 provides installation instructions for the System. Below is a brief summary of each chapter.

Introduction:	This chapter is an overview of the entire Satellite Derived Sea-Surface Temperature (SST) Processing System operating in the workstation environment. It contains only brief descriptions of data transfers and processes, and does not discuss procedures in detail.
Routine Run of the GOES Satellite Derived Winds Processing System:	This chapter briefly discusses each major process involved in the production of the GOES SST products. A discussion of the criticality of each process, as well as the data required for each process, is also provided.
Operator Monitoring and Recovery:	This chapter is designed to be explicit "how-to" instructions telling the operator exactly when and how to monitor the various processing segments of the SST processing system. It goes on to detail specific recovery procedures for each element.
SST System Information:	This chapter outlines scheduled jobs, data files, and the system log files. The data file listing and log files will aid operations personnel in their monitoring activities.
System Maintenance:	This chapter discusses possible system problems and the steps to take to reestablish McIDAS-X software and reboot the UNIX workstation.
Installation Procedures:	This chapter outlines detailed procedures for installing and configuring the GOES SST product system. This includes installing and compiling the SST software, scheduling jobs on the McIDAS-X workstation.

2. Introduction

The GOES Satellite Derived SST Product System is designed to incorporate GOES multispectral information for channels 1,2,4 and 5 to derive sea-surface temperature. Extensive screening for cloud contamination affect the regression equation are performed on these channel measurements to yield clear sky radiance values. Four regression equations are produced for GOES-E and GOES-W during the day and night covering 30°W - 180°W, 45°S - 60°N.

$$SST = C_0 + C_1 T_4 + C_2 dT + C_3 dT^2 + C_4 (sec\ q - 1)$$

where,

C_i, i=1,4 are provided in regression coefficients and may be updated from time to time, $dT = T_{11} - T_{12}$ for daytime only and $T_{3.9} - T_{11}$ for nighttime only, and q is the satellite viewing angle.

Production of the experimental GOES SST began on October 1, 1998. The current GOES operational SST production system runs in an automated fashion every half hour. Products from the SST Processing System include hourly composite SST, 3-hour composite SST, and sector SST imagery for CoastWatch regions for the NorthEast, SouthEast, Great Lakes, Gulf of Mexico, La Hoya, Hawaii and Fairbanks, Alaska Node Sites.

3. Routine Run of the GOES-8/10 Satellite Derived SST Processing System

The GOES Satellite Derived SST Processing System runs in an automated and time-scheduled fashion. The production cycle begins with the transfer of the necessary imager AREA files from the GER or GWR server and hourly buoy data to the ORIGIN 2000 workstation. From these data, hourly and 3-hourly SST AREA sector files and composite SST AREA files are derived. All processing takes place under usernames goessst and goesW on the ORIGIN 2000 with the data being stored in $HOME/ mcidas/data.

A block diagram of the SST production cycle is shown in Figures 3-1. This section is not intended to give an extensive description of processing, but rather a basic overview of each step from the operator's point of view. This overview, however, will address the criticality of the data being processed as it relates to the production of the SST products. Section 4 will address issues relating to operator monitoring and recovery.

3.1. The GOES-8/10 SST Production Cycle

There are numerous processing steps involved in the production of GOES satellite-derived SST. The first processing step involves the transfer of the single band imager AREA files to the ORIGIN 200 workstation. The core McIDAS function, **IMPGCOPY** is used to transfer these files to the local server. The second step is to resample the 1km visible image to 4km resolution. The program **AVGIMI.PGM** is used for this purpose. The third step is the creation of multispectral AREA files using the program **GIMIGLUE.C**. Multispectral AREA files are then used in the **GOES_SST.PGM** algorithm in step five to generate SST imagery areas files for the four sectors. Next, composite SST hourly and 3-hourly files are generated using the **MERGE.PGM** routine. Finally, statistical comparisons of satellite and buoy SST's are made for 3 x 3 areas using the **BUOY.PGM** routine. A description of each of these processes is discussed below in the following sections.

The SST processing scripts are scheduled to run as early as possible, consistent with all the GOES imager dat avaiable on the GER and GWR operational servers. The scheduling of the script and the processing timelines are described in Figure 3-2.

3.1.1 GVAR Data Ingest/McIDAS Decoding

Description: The GOES SST processing system is dependent upon a successful GVAR ingest and decoding process. The ingesting of GVAR data and the subsequent decoding of this data into McIDAS imager area files provides the satellite imagery necessary for the production of GOES SST products. The GOES imager channels 1-5 are decoded into separate area files on the GOES ingestor. For imager-based SST processing, all 5 bands are transferred to the appropriate server (GER for GOES-EAST; GWR for GOES-WEST). ADDE software is used to transfer the imager areas from the GOES image servers to the SGI Origin 2000 SST workstation. The ADDE dataset names, for imagery, used by the SST processing system are given in Table 3-1.
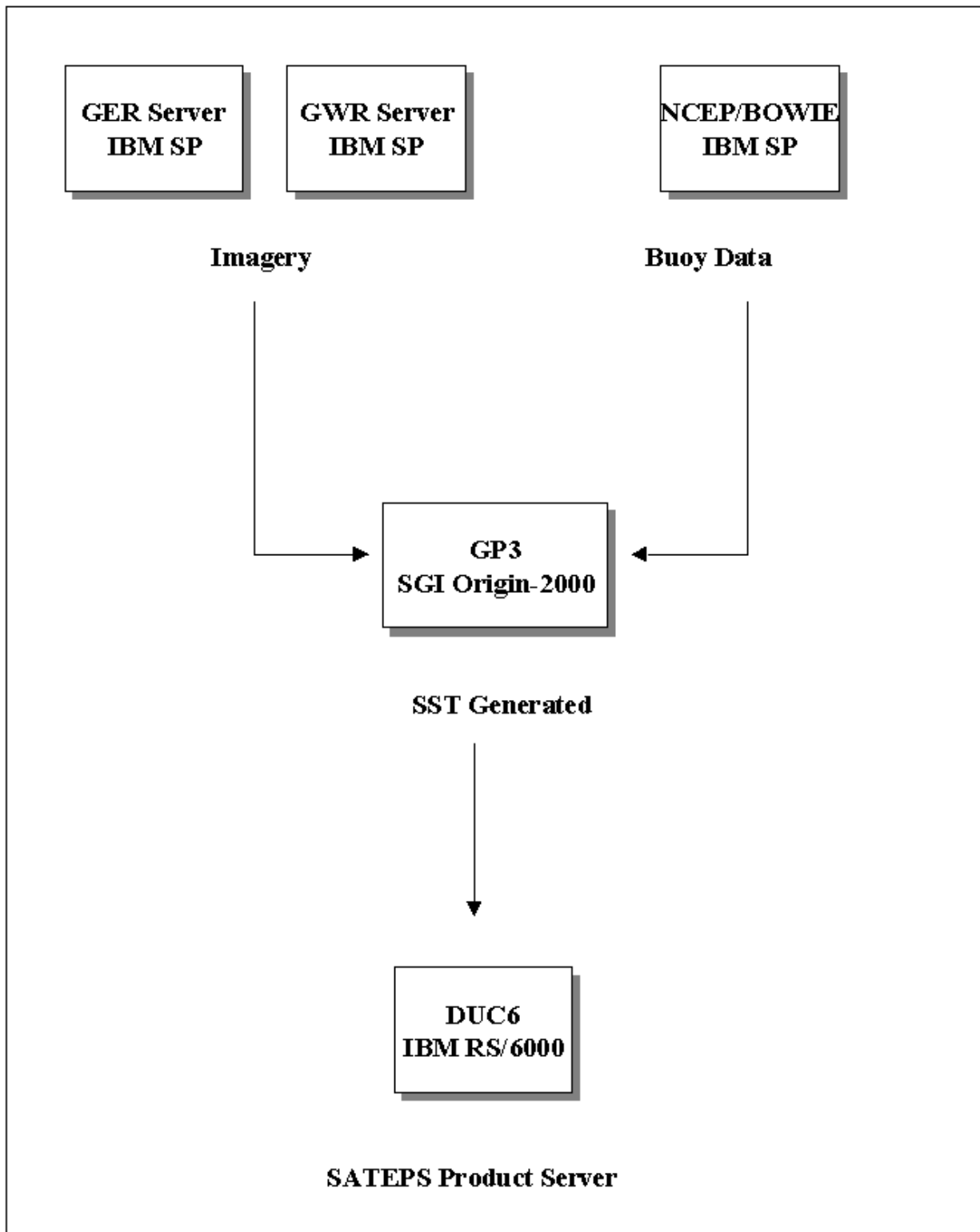
```
┌─────────────────────────────────────────────────────────────┐
│                                                             │
│   ┌──────────────┐  ┌──────────────┐     ┌──────────────┐   │
│   │ GER Server   │  │ GWR Server   │     │ NCEP/BOWIE   │   │
│   │   IBM SP     │  │   IBM SP     │     │   IBM SP     │   │
│   └──────────────┘  └──────────────┘     └──────────────┘   │
│                                                             │
│            Imagery                          Buoy Data       │
│                                                             │
│                     ┌──────────────────┐                    │
│                     │       GP3        │                    │
│                     │ SGI Origin-2000  │                    │
│                     └──────────────────┘                    │
│                                                             │
│                     SST Generated                           │
│                                                             │
│                     ┌──────────────────┐                    │
│                     │      DUC6        │                    │
│                     │  IBM RS/6000     │                    │
│                     └──────────────────┘                    │
│                                                             │
│                  SATEPS Product Server                      │
│                                                             │
└─────────────────────────────────────────────────────────────┘
```

Figure 3-1. Hardware configuration for the GOES Satellite derived SST Processing System

GOES SST PROCESSING SCRIPTS

SCRIPT	MINUTE	HOUR	DAY	MONTH	DAY OF WEEK
getdata_hh15.ksh	05	*	*	*	*
procgsst_hh15.ksh	25	*	*	*	*
getdata_hh45.ksh	35	*	*	*	*
procgsst_hh45.ksh	55	*	*	*	*
cleanup.ksh	05	00	*	*	*
clean2000.ksh	15	00	*	*	*
hourlysst.ksh	05	*	*	*	*
3hourly.ksh	05	00,03,06,09, 12,15,18,21	*	*	*
buoymatch.ksh	40	*	*	*	*
getbuoy.ksh	55	*	*	*	*

Figure 3-2   SST processing scripts and when each is run. A '' indicates that it is to run continuously for that given parameter*

GVAR DATA INGEST/McIDAS Decoding

GOES-EAST Server (GER) ADDE Group/Dataset Name	Description	GOES-WEST Server (GWR) ADDE Group/Dataset Name
GER/GENHEM01V	Imager Band 1; extended Northern Hemisphere (1 km res)	GWR/GWNHEM01V
GER/GENHEM04I2	Imager Band 2; extended Northern Hemisphere (4 km res)	GWR/GWNHEM01I2
GER/GENHEM04I4	Imager Band 4; extended Northern Hemisphere (4 km res)	GWR/GWNHEM04I4
GER/GENHEM04I5	Imager Band 5; extended Northern Hemisphere (4 km res)	GWR/GWNHEM04I5
GER/GESHEM01V	Imager Band 1; extended Southern Hemisphere (1 km res)	GWR/GWSHEM01V
GER/GESHEM04I2	Imager Band 2; extended Southern Hemisphere (4 km res)	GWR/GWSHEM04I2
GER/GESHEM04I4	Imager Band 4; extended Southern Hemisphere (4 km res)	GWR/GWSHEM04I4
GER/GESHEM04I5	Imager Band 5; extended Southern Hemisphere (4 km res)	GWR/GWSHEM04I5

Table 3-1   ADDE group and dataset nmaes for GOES-EAST imagery residing on GER server and GOES-West imager residing on the GWR server.

Criticality: The GOES SST processing system is dependent upon a successful GVAR ingest and decoding process. The ingesting of GVAR data and the subsequent decoding of this data into McIDAS imager area files provides the satellite imagery necessary for the production of GOES SST products.

3.1.2 Imager AREA File Transfer

Description: This process involves the transfer of valid, high quality, GOES imagery for SST processing to the local server. An ADDE program **imgcopy** is used to transfer incoming GOES channel data to the local server. There are several criteria which must be met for accessing imagery for SST processing. They include:

1)   The time of each image is computed in each imgcopy cycle. Times are generally 30 minutes apart.

Criticality: Successful transfer of the single-band imager AREA files from the GER server to the ORIGIN 200 workstation, along with the successful production of a multispectral imager AREA file, is essential to the production of the SST products. SST processing will fail if this process is not successful.

3.1.3 Creation of Multiband AREA Files

Description: In order to generate SST products, the main program, GOES_SST.PGM, requires multispectral AREA files containing GOES channels 1,2,4 and 5. Two programs (AVGIMI and GIMIGLUE) are used to generate the GOES multispectral datasets.

Criticality: Successful transfer of the single-band imager AREA files from the GER server to the ORIGIN 200 workstation, along with the successful production of a multispectral imager AREA file, is essential to the production of the SST products. SST processing will fail if this process is not successful.

3.1.4 Creation of SST Imagery AREA Files

Description: After the local AREA files have been converted into multichannel imagery, the GOES SST script calls the main program **goes_sst**, which applies a regression-based algorithm on GOES satellite data to generate the sea-surface temperature products.

Criticality: The output from goes_sst is SST imagery AREA files for each of the four sectors. Quality control screening through cloud and threshold testing is performed to identify suspicious or spurious data.

3.1.5 Creation of hourly and 3 hourly sector and composite SST AREA Files

Description: This part of process uses the main program, MERGE.PGM, to take SST AREA files by sector for each half hour and create hourly composite and sector SST AREA files. Every three hours, the main program, MERGE.PGM, will also create 3-hourly composite SST AREA files.

Criticality: The output from the MERGE routine is hourly and 3-hourly composites and all CoastWatch sector files.

3.1.6 Collocation of SST Products and Buoy Measurements

Description: Comparisons of satellite derived SST to buoy data is done as a quantitative measure of the GOESSST quality. The statistics generated are used to evaluate changes to improve the quality of the SST products. The main program, BUOY.PGM, is used to generate these comparisons of buoy and SST data.

Criticality: The **buoy** routine collects co-located buoy data, GOES measurements, and SST product. This data will be used to provide quality control and future improvements on the satellite-derived sea-surface temperatures.

3.1.7 Distribution of Products

Description: he UNIX shell scripts **hourlysst.scr**, **3hourly.scr**, and **buoymatch.scr** transfer the hourly, 3-hourly and buoy match data respectively from the mcidas data directory to the local archive directory. In doing so the files are given more mnemonic names. The scripts then transfer the datasets, under the new names, to the SATEPS product server using ftp.

Criticality: If the rename transfers to archive and/or transfers to the product server fails, the GSST results cannot be accessed by users.

4. Operator Monitoring and Recovery

SST processing is fully automated, requiring no operator intervention. Many of the data problems will be due to a lack of satellite data on the servers. Without satellite imagery, no product can be made. For other types of failures there are at present no recovery procedures for missed products because the machine capacity is insufficent to recover one product while producing another. Thus operator monitoring and recovery currently consists solely of operator monitoring.

4.1 Hourly Monitoring

To perform hourly monitoring, at the UNIX prompt on the goessst machine (gp3) type: ***checkgsst***

The procedure will look for the three types of output products. The operator should check off the boxes for whether the products succeeded or failed. There is no recovery procedure for failures, but if there are four consecutive failures for any of the products, call the gsst support programmers.

5. SST System Information

This section discusses all of the scheduled entries required for the GOES-E/W SST Processing System. As discussed above, the processing cycle is controlled by several scripts, and they are described as follows:

3HOURLY.KSH

A UNIX Korn shell script to copy the 3-hourly SST and CoastWatch sector files from the McIDAS data directory to local archive directory and to transfer to the product server via ftp.

BUOYMATCH.KSH

A UNIX Korn shell script to copy the hourly buoy matchup results from the McIDAS data directory to the local archive directory and transfer to the product server via ftp.

CLEAN2000.KSH

A UNIX Korn shell script run nightly to clean up $HOME/mcidas/data directory. The script deletes N-day old SST output files (i.e. 2000_243.17 and 2000_244_33A).

CLEANUP.KSH

A UNIX Korn shell script to delete old SST output files from the archive directory.

GETBUOY.KSH

A UNIX Korn shell script to retrieve buoy data from the IBM_SP via ftp.

GETDATA_HH15.KSH

A UNIX Korn shell script to transfer GOES imagery to the local server for SST processing.

GETDATA_HH45.KSH

A UNIX Korn shell script to transfer GOES imagery to the local server for SST processing.

HOURLYSST.KSH

A UNIX Korn shell script to copy hourly SST files from the McIDAS data directory to the local archive directory and transfer via ftp to the product server.

PROCGSST_HH15.KSH

A UNIX Korn shell script to transfer GOES imagery files to the local server, create multispectral GOES 4-band AREA file, generate SST AREA files, and generate composite SST AREA files.

PROCGSST_HH45.KSH

A UNIX Korn shell script to transfer GOES imagery to the local server, create multispectral GOES 4-band AREA file, generate SST AREA files, and generate buoy matchup files.

This section contains a description of the data files and log files pertinent to SST processing. The description of the data and log files is meant to supplement the dataset information discussed in the previous section.

5.1 Scheduling the GOES SST Processing Scripts

The GOES SST processing runs on a time scheduled basis. Because processing requires the presence of input imagery, the image transfer scripts are scheduled to execute only when all imagery is expected to be present. This is at hh:05 for getdata_hh15.ksh and hh:35 for getdata_hh45.ksh. To allow adequate time for the imagery to arrive, the processing scripts procgsst_hh15 and procgsst_hh45 are in fact scheduled for hh:29 and hh:59. Note that these scripts use their execution time to decide what times the input satellite data should have. Scheduling these scripts outside their half hour requires revisions to the scripts.

5.2 Data Files

The satellite-derived SST Processing System requires a variety of input data files. The primary data are AREA files and buoy report data. The AREA files are resident on the GER and GWR servers, while the buoy data resides on IBM SP/Bowie. These data files reside in directory $HOME/mcidas/ data on the ORIGIN 2000. The following subsections indicate what each data file is and where each resides.

5.2.1 GER/GWR Server AREA Files

The AREA files used by the GOES-E/W SST processing system reside on the GER and GWR file server and are transferred to the ORIGIN 2000 via the ADDE IMGCOPY command where they are written to user-defined datasets (e.g., GER/GENHEM04I4 would be the dataset name for the extended northern hemisphere band 4 images). Below is a complete list of all the datasets which need to be configured displayed by typing in DSSERVE at the McIDAS command line.

```
Group/Descriptor           Type  Format & Range      RT Comment
------------------------   ----- ------------------  -- ──────────
LD/A                       IMAGE AREA      1-9999    LOCAL Imagery
```

5.2.2 Binary Files

5.2.2.1 Log Files

The GOES SST Processing System contains four logfiles (getdata_hh15.ksh, procgsst_hh15.ksh, getdata_hh45.ksh, and procgsst_hh45.ksh), which contain diagnostic and error messages. The log files are cumulative, with weekly pruning. Here is a sample from the getdata_hh15.log file:

Thu Dec 7 08:05:04 UTC 2000 start getdata_hh15.ksh
GOES-E NHem image between   7:35 and 7:55 on date 2000342
imgdel.k: done
imgdel.k: done
 imgcopy.k GER/GENHEM01V LD/A.1950 PLACE=ULEFT LINELE=2805 9049 I BAND=ALL DOC=YES
SIZE=7308 13840   DAY=2000342 TIME=7:35 7:55
Beginning Image Data transfer, bytes= 203984384
Transferring AREA data outbound, bytes= 203984544
IMGCOPY: GER/GENHEM01V.4 copied to LD/A.1950
imgcopy.k: done
Beginning Image Data transfer, bytes= 13070192
Transferring AREA data outbound, bytes= 13070352
IMGCOPY: GER/GENHEM04I2.25 copied to LD/A.952
imgcopy.k: done
Beginning Image Data transfer, bytes= 13070192
Transferring AREA data outbound, bytes= 13070352
IMGCOPY: GER/GENHEM04I3.25 copied to LD/A.953
imgcopy.k: done
Beginning Image Data transfer, bytes= 13070192
Transferring AREA data outbound, bytes= 13070352
IMGCOPY: GER/GENHEM04I4.25 copied to LD/A.954
imgcopy.k: done
Beginning Image Data transfer, bytes= 13070192
Transferring AREA data outbound, bytes= 13070352
IMGCOPY: GER/GENHEM04I5.25 copied to LD/A.955
imgcopy.k: done
Got GOES-E NHem at Thu Dec 7 08:08:20 UTC 2000
GOES-E SHem image between   7:35 and 7:45 on date 2000342
imgdel.k: done
imgdel.k: done

6. System Maintenance

This chapter is more suited for the system administrator and discusses the corrective actions which can be taken to resolve system/workstation problems dealing with McIDAS-X and/ or the workstation itself.

6.1 Rebooting the ORIGIN 2000 Workstation

If the ORIGIN 2000 workstation has crashed, the system administrator should be called in to check on the problem. If the connection to the GP3 is lost, do the following to reestablish it.

      a)   Log into the INDY hhs3 as oper
      b)   Open a X-window
      c)   Type "xhost +gp3"
      d)   Telnet to gp3 as user goessst
      e)   Type "xterm &" to create a resizable xterm window.

6.2 Fallback for Extended System Down Time on the ORIGIN 2000 Workstation

There is not at present a backup system for GOESSST. If goessst is still running on the ORA machine, copy the calibration area files (AREA0[1-4]00 ... AREA0[1-4]23) to GP3. Otherwise it may take several days for the local system to stabilize.

6.3 Utilities For System Observation/Maintenance/Analysis

This section contains a listing of several programs which can aid a system analyst or operator in looking at the data. The use could be purely for observational purposes or for analytical purposes or for system maintenance (i.e., troubleshooting) purposes. There are many utilities serving diverse purposes.

6.3.1 Utility Listing

Area Files: **IMGLIST:**   Lists image directory information
                     IMGDISP: Displays image data from a server to a frame

6.3.2 Utility Examples

The utilities IMGLIST and IMGDISP are all core utilities. Therefore, help is available on them if needed. Below is a list of examples to aid the user in utilizing these programs on files used or generated by the SST processing system.

IMGLIST LD/A.0130 0132

Lists the local multiband imagery files for NATL region.

IMGDISP LD/A.0142 MAG=-4 -8

Displays the latest SST image result for NATL.   The SST output imagery is sampled every fourth line and every eighth element

7. Installation Procedures

7.1 Installation of Software and Data

The steps involved in installation are relatively straightforward assuming a tape backup of the original software/data is made. These backups should be made periodically to keep up with any changes which may occur to the software/data. Below is a list of the steps involved in installing the software/data on a new machine.

Important Note: A backup tape of current software/data on the ORIGIN 2000 (GP3) must be made beforehand in order to perform this installation.

A)   Make a tape backup of the original workstation using the "tar" command. The system administrator should know how to execute the "tar" command, as it is standard UNIX. The process would be to:

>   cd $HOME/mcidas
>   tar -cvf gsstprogs.tar src lib bin ksh data/

The following directories should be backed up for the SST product processing system:

>   **1.** $HOME
>   **2.** $HOME/mcidas
>   **3.** $HOME/mcidas/src
>   **4**. $HOMEmcidas/ksh
>   **5.** $HOME/mcidas/lib
>   **6.** $HOME/mcidas/bin
>   **7.** $HOME/mcidas/data
>
>   Selected files for $HOME/mcidas/data include:
>   reg_coef.*
>   link_guess
>   AREA0100 ... 0123. AREA0200 ... 0223, AREA0300 ... 0323, AREA0400 ... 0423

B)   Install McIDAS-X on the workstation to be used.

C)   Create the above directories using the "mkdir" command. The system administrator should know how to do this.

D)   Using the "tar" command, copy all software and data off of the tape and into the proper directories listed above.

    Note: The instructions below are meant to serve merely as a **guide** during configuration and may have to be modified slightly to suit the users needs.

E)   Recompile all of the SST software, which resides in a single directory ($HOME/mcidas/src) under the goessst user account. The compile script resides in the ~/mcidas/src directory and is named **compile_gsst**.

The procedure, then, to compile the SST software is simply to run the **compile_gsst** executable by doing the following:

       1)   Login
       2)   Change directory to the $HOME/mcidas/src directory (i.e. type cd $HOME/ mcidas/src).
       3)   Compile the SST software by typing: '**compile_gsst**'

F)   Restore the crontab file to schedule execution of the jobs (cd $HOME/mcidas/data, crontab crontab.save).

G)   Revise scripts if archive directory or product server name/directory has changed. Revise $HOME/ .netrc to include product server, buoy data server. Verify that all scripts are executable.

H)   Have the system administrator ensure that the product server has permission to allow data to be placed on the new machine (ftp access).

I)   Configure ADDE to access and store the satellite imagery. This involves using the McIDAS DATALOC and DSSERVE commands. The DATALOC command is used when accessing a remote server while the DSSERVE command sets up the local server. The following commands need to be entered at the McIDAS command line:

       1)   DATALOC ADD GER 140.90.105.41
       2)   DATALOC ADD GWR 140.90.105.51
       3)   DSSERVE ADD LD/A AREA 1 9999 "ALL LOCAL AREAS

7.2 Installation Changes Concerning System/Configuration Upgrades

Numerous different types of system configuration changes or system upgrades may result in changes in installation procedures or other system level changes. This section discusses briefly some of the more important changes.

7.2.1 McIDAS-X Upgrades

The system administrator should be fully aware of what needs to be done for a McIDAS-X upgrade. At the very least the following steps should be completed. Once a new McIDAS upgrade is installed, recompile the mcidas software (see section 7.1 E).

cp $HOME/mcidas/lib/libmcidas.a $HOME/lib

Now follow the instructions in Section 7.1 for compiling the SST software.

The above will bring in the new libmcidas.a file. The user will then re-compile the SST source code by running **compile_gsst**.